



## Electrical breakdown phenomena of dielectric elastomers

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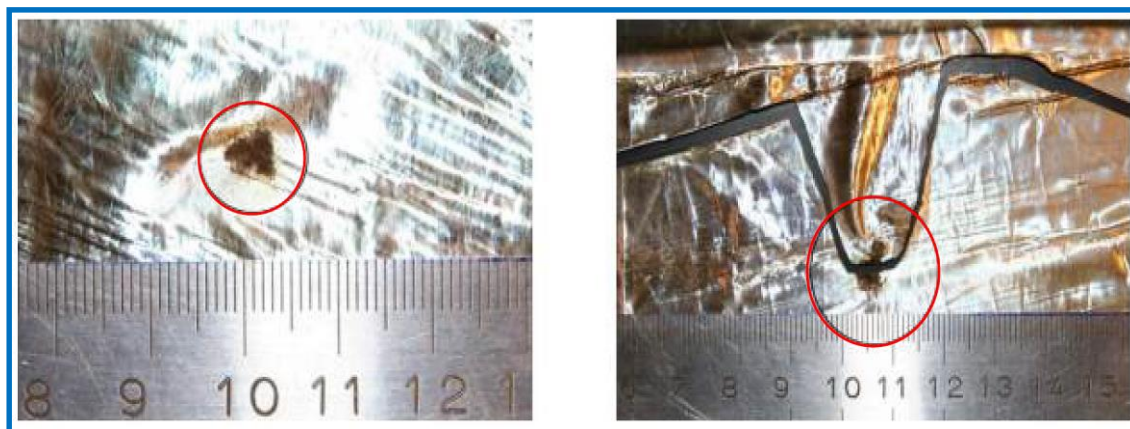
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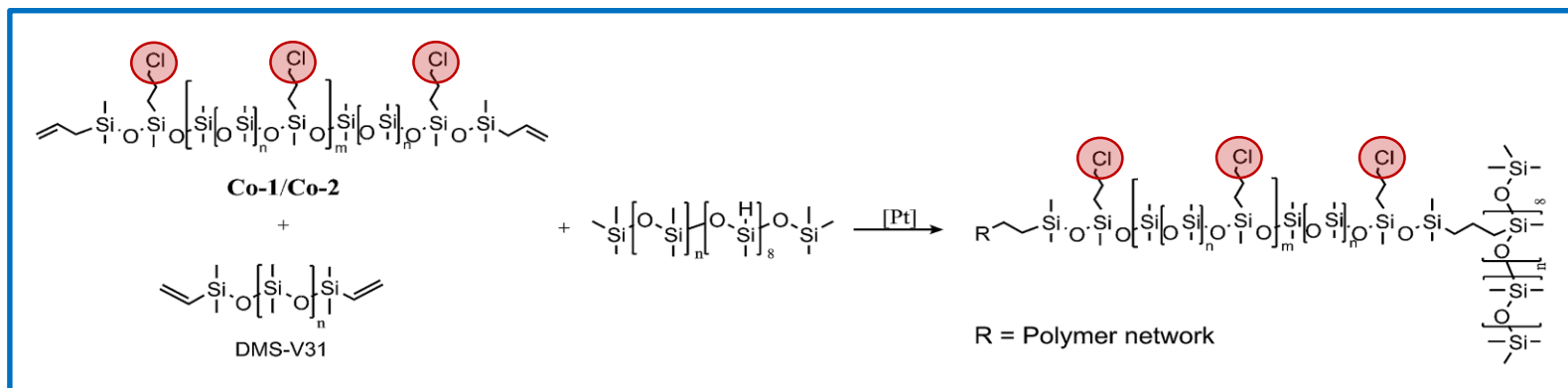
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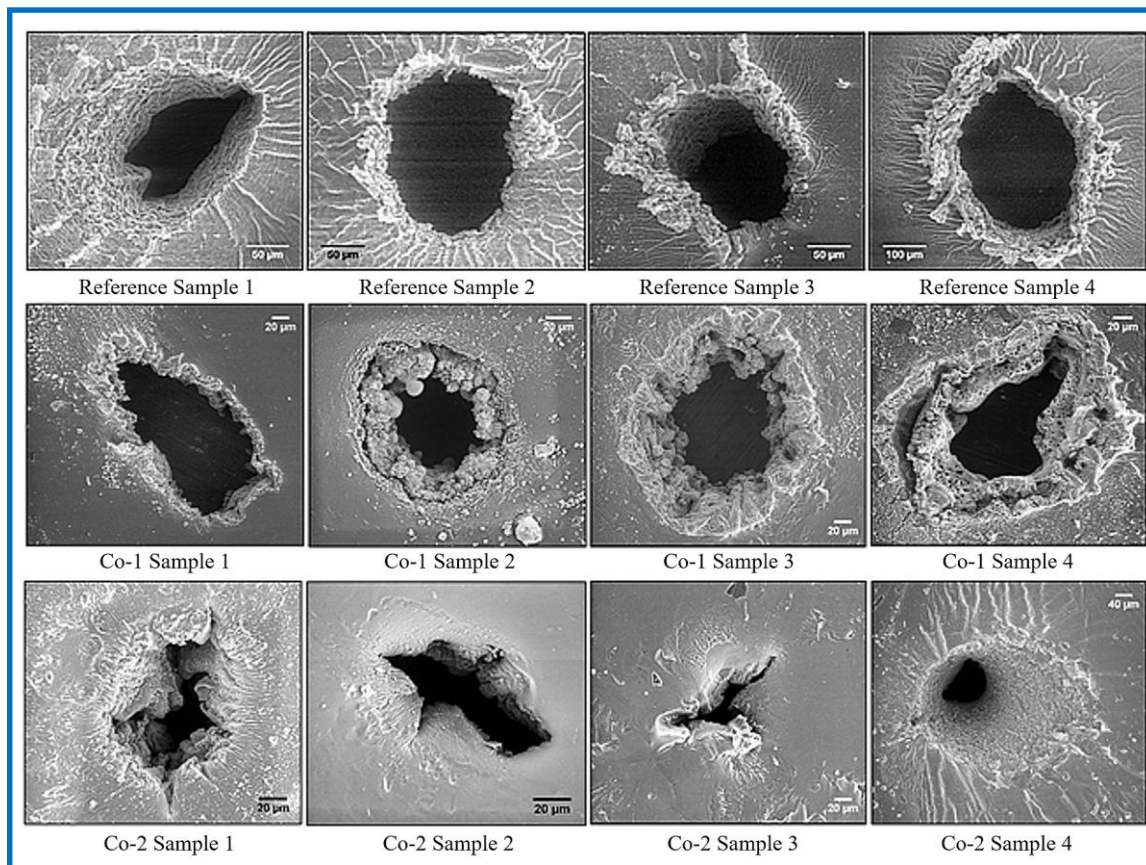


**Figure 1.** Electrical **breakdown** causes a **pinhole** formation on DEs film leading to major damage of the DE based devices.



**Figure 2.** The structure of **chloro propyl** functional silicone elastomer.<sup>[1]</sup>

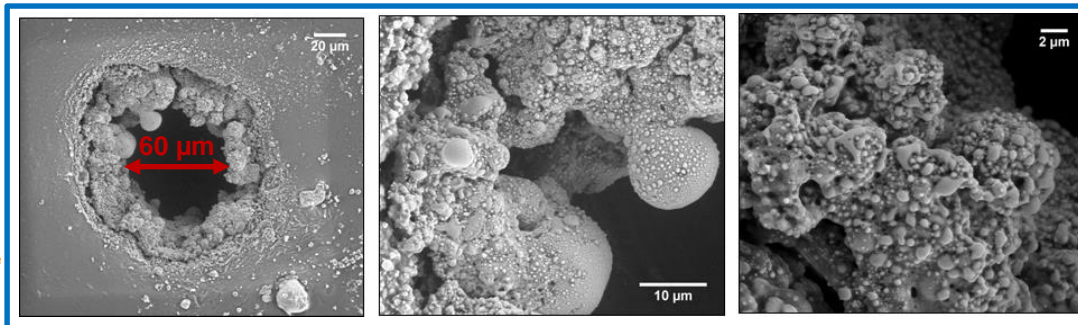
### Scanning Electron Microscope (SEM) - Morphology



**Figure 4.** SEM images of breakdown zones for **reference samples**, **Co-1** and **Co-2** silicone elastomers. The black areas correspond to areas where the elastomer was completely removed during breakdown, i.e. pinholes.

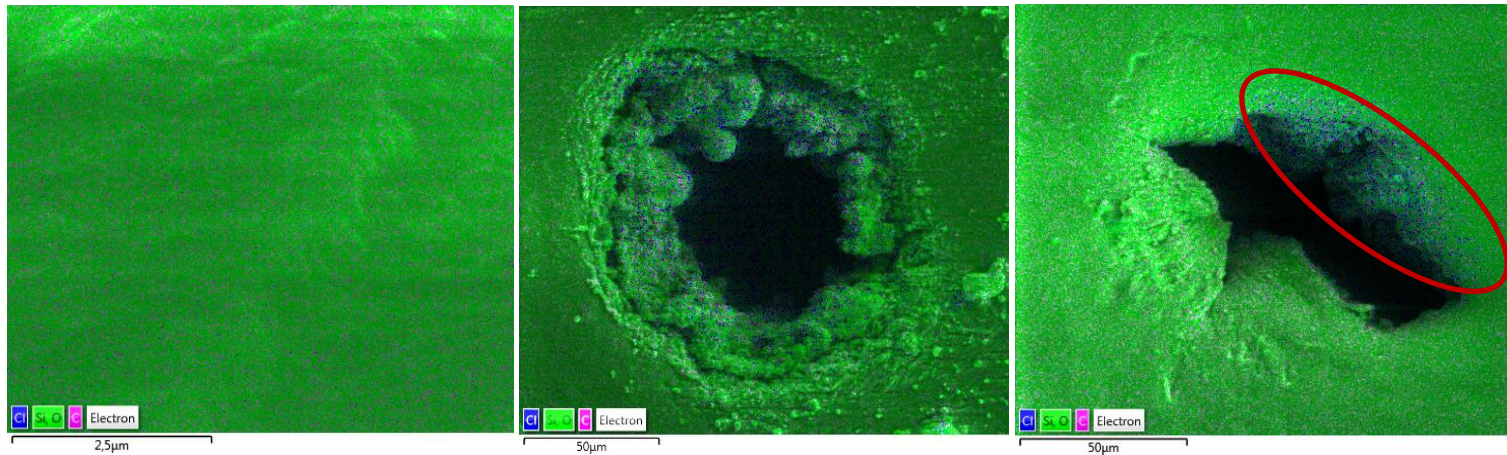
Breakdown zones vary dimensionally with narrowest width to largest width:  
**Reference:** 100-300 μm  
**Co-1:** 60-100 μm  
**Co-2:** 20-80 μm

**Figure 5.** Illustration of **boiling nature** of the crosslinked copolymer **Co-1** in different magnifications. Droplets of condensing degradation products are formed on the surface of the breakdown zone.

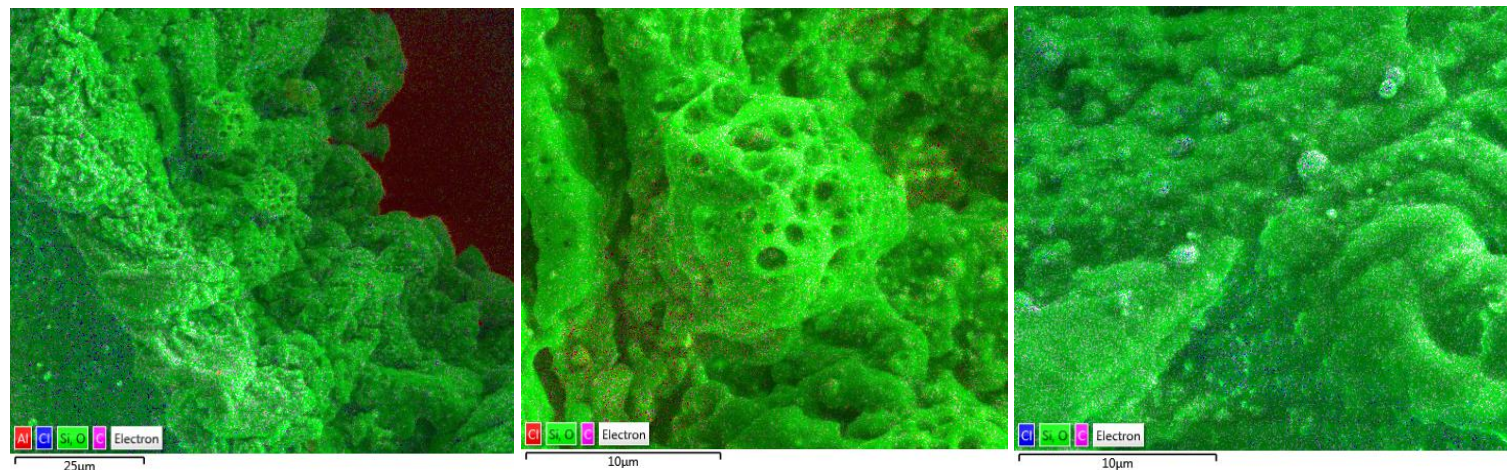




### Energy Dispersive X-Ray Spectroscopy (EDS) - Elemental Distribution



**Figure 6.** EDS mapping of **Co-2** elastomer surface where **Cl** is **uniformly distributed** (left), breakdown zones for **Co-1** (middle) and **Co-2** (right). The material in the **vicinity** of the **void** contains excess of **Cl** (blue color), which support the hypothesis that *silicon-containing substances have been evaporated off*.



**Figure 7.** An increased concentration of Cl is recorded at the breakdown zones for the crosslinked copolymer Co-1.